EDYS Application: Linking with Hydrological Models

Background

Hydrological models have been developed by a wide range of researchers and engineers for management of surface and groundwater quantity and quality. Although these models have proven to be highly effective management tools, they have focused almost entirely on physical processes with little consideration of ecological dynamics. It is ordinarily assumed that plant communities have negligible impacts on hydrological dynamics, but this is not the case in many terrestrial, riparian, and wetland systems. For example, it is commonly speculated that brush invasion in many parts of the southwestern United States has resulted in significant reductions in flow in streams and rivers. Expensive control programs for juniper and salt cedar have been widely implemented with little insight into long-term cost-effectiveness.

Impact assessments of hydrological alteration on vegetation and of vegetation on water supply can be greatly facilitated by linking existing hydrological models with general ecosystem models designed to make long-term projections of ecosystem dynamics. The **Ecological Dynamics Simulation (EDYS)** model is well-suited for linking with other models because it is designed to simulate ecological processes at multiple spatial and temporal scales. In particular, **EDYS** computes small-scale flows (precipitation, interception, evaporation, infiltration, and transpiration) on a daily basis, and can thereby provide much more accurate estimates of evapotranspiration and groundwater uptake and recharge than would ordinarily be available for calibration of runoff and groundwater models. **EDYS** developers are able to rapidly develop interfaces between various **EDYS** modules and corresponding components of hydrological models to coordinate exchanges of data and results.

CASC2D Surface Water Hydrology

EDYS was first linked with the **CASC2D** surface water hydrological model (Dr. Fred Ogden, University of Connecticut) to simulate hydrological dynamics in the Hanson Creek watershed on Fort Hood, Texas. Like **EDYS**, **CASC2D** is grid-based, so both models were implemented with the same watershed grid. In this application, **EDYS** was run for day-to-day hydrological processes until a storm event occurred. Then **EDYS** would output current hydrological conditions to **CASC2D**, which would simulate runoff and channel flow for the duration of the event. At the end of the event, **CASC2D** would output hydrological data to **EDYS**, which would then resume the simulation until the next storm event.

MODFLOW Groundwater Hydrology

Wellfields in the Owens Valley of eastern California provide a substantial portion of water needs for the City of Los Angeles. However, there are concerns about the impact of groundwater pumping on vegetation in the Valley, especially along existing riparian corridors where groundwater depth is shallow. **EDYS** in now being linked to **MODFLOW**, a grid-based groundwater model, to project short- and long-term effects of alternative groundwater pumping scenarios on vegetation. Prior to application of **EDYS** to plant communities across the Valley, it was assumed without verification that vegetation had little impact on groundwater, even though interception and transpiration had a significant impact on recharge from precipitation. The **EDYS** -**MODFLOW** linkage will allow the city to better evaluate ecological impacts of groundwater pumping, and to identify pumping strategies for minimizing adverse impacts.

HSPF Surface Water Hydrology

A new project will develop a linkage between **EDYS** and **HSPF**, a powerful surface water quality and quantity model originally developed through support from US EPA. The linked models will be applied to the upper Cibolo Creek watershed north of San Antonio, TX. The overall objective is to evaluate the feasibility of constructing water retention structures for flood damage control and recharge to the Edwards Aquifer. The impetus for including **EDYS** in the evaluation is to address issues of potential losses to evapotranspiration from juniper encroachment, urban/suburban growth, and other land use changes in the watershed.

US Army Corps of Engineers SMART Program

The Engineer Research and Development Center (ERDC) of the US Army Corps of Engineers is implementing a new research program focused on basin-wide approaches to land and water management and ecological restoration. One objective of this program is to develop dynamic linkages between existing physical and ecological simulation models to provide decision support tools for resource managers. **EDYS** developers will support the ERDC in linking simulation models to provide a "System-wide Modelling, Assessment and Restoration Technologies" (**SMART**) capability. Additional ERDC modelling capabilities to be included in the program will simulate soil erosion and sediment transport, surface water, groundwater, channel flow, reservoirs, wetland dynamics, tidal dynamics, estuarine and marine circulation, air quality, and socioeconomics. Because the **EDYS** application team already has significant experience in linking **EDYS** with hydrological models, the **SMART** program should make rapid progress in adding additional models for testing and validation at demonstration sites across the United States.

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